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Hexactinellida (Porifera) from the ANDEEP III Expedition to the Weddell Sea, Antarctica

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Abstract

New Hexactinellida from the deep Weddell Sea collected in 2005 during the ANT XXII/3 expedition (ANDEEP III) are described. This hexactinellid fauna includes 12 species from 8 genera, 2 of which are new to science: *Lophocalyx profundum* **n. sp.** and *L. topsenti* **n. sp.** It further contains the first record of *Caulophacus* (*Caulodiscus*) *valdiviae* in the Weddell Sea, and the second findings of the species *Acoelocalyx brucei* and *Caulophacus* (*Oxydiscus*) *weddelli* since their original descriptions. The Southern Ocean deep-sea, including the deep Weddell Sea, still offers a challenging potential for the discovery of new taxa.

Key words: Porifera, Hexactinellida, Antarctica, new species, deep-sea sponges

Introduction

Although most of the Southern Ocean is composed of bathyal and abyssal areas, the majority of its known sponge species are described from the Antarctic Shelf and the Subantarctic islands, and mostly from depths less than 500 m. The Weddell, Scotia and Lazarev Seas constitute the Atlantic sector of the circumantarctic Southern Ocean, the sea extending from the Antarctic coasts northward to 60°S (International Hydrographic Organization 2000). The Weddell Sea covers approximately 2.8 X 10^6km^2. Over most of their areas, the Weddell and Scotia Seas are 4000–5000 m deep, although some minor ridges define a number of basins. The continental shelf is generally narrow, the shelf edge is located at 500–800 m depth, and the slopes are mostly rather steep. Whereas the benthic fauna of the Weddell Sea shelf areas is rather well known, our knowledge about life at the bottom of the bathyal and abyssal Weddell Sea is meager at best. Our present data on the Antarctic deep-sea Porifera originate mainly from scattered older expeditions (overview of the sponge literature from the earlier expeditions is given by Barthel & Tendal 1994 and Janussen & Tendal 2007). In general, taxonomy of the class Hexactinellida is incomplete in the sense that probably not even half of its species are known to science. This is obvious from the fact that repeatedly many of the hexactinellid species collected during recent deep-sea expeditions are new to science. Furthermore, many hexactinellid species and even genera are known only from one, sometimes only a fragmented ‚specimen. A collection of hexactinellids from the deep Weddell Sea, described by Janussen et al. (2004) from the ANDEEP II-Expedition, included 14 species belonging to 12 genera, of which five species and one subgenus were new to science. In this report, we describe further Hexactinellida from the deep Weddell Sea, collected by one of the authors (DJ) in 2005 during the ANDEEP III-Expedition. For further data concerning the ANDEEP expeditions sponge collection and sampling sites see Janussen (2003, 2006).

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Materials and methods

The hexactinellid sponges described herein were collected during the ANT XXII/3 (21.01.–06.04.2005) expedition by the RV *Polarstern*. This cruise was the continuation of the ANDEEP II expedition in 2002, as part of the international research programme ANtarctic benthic DEEP-sea biodiversity, initiated by Angelika Brandt (Univ. Hamburg). The studied Hexactinellida were collected at 10 ANDEEP-stations from 1000–5000 m depths, eight stations were sampled by a large Agassiz trawl (3 m across), and two by an epibenthic sledge. All sponges were collected by D. Janussen, photographed and preserved in 96 % ethanol; large and abundant *Rossella* specimens were partly fixed in 6 % formaldehyde and later preserved in 70 % ethanol; some were dried. Skeletal elements (spicules) of the sponges were studied on preparations following the generally accepted technique of dissolving soft tissue of fragments of sponge in nitric acid; the preparation procedure is described e. g. by Boury-Esnault & Rützler (1997). The spicules were mounted on microscope slides and studied by light microscopy (LM), or on stubs and sputter-coated for study by scanning electron microscopy (SEM). Measurements of spicules for all data tables were made using a computer-digitizer joined to compound or dissecting light microscopes by drawing tube (camera lucida) and Sigma-Scan© software; spicule measurements for routine identification were made with calibrated ocular micrometer. The ANDEEP samples were deposited in the sponge collection of Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt am Main (SMF). Additional comparative material was borrowed from other Museums, e. g. sponges from the EASIZ expeditions, 1994-2004 (Ecology of the Antarctic Sea Ice Zone). The following institutions provided material for this study: Natural History Museum, London (BMNH); Royal Scottish Museum, Edinburgh (RSM); United States National Museum, Smithsonian Institution, Washington (USNM); Zoological Museum, Hamburg (ZMH).

Taxonomy

Class Hexactinellida Schmidt, 1870

Order Hexasterophora Schulze, 1899

Suborder Hexactinosida Schrammen, 1903

Family Euretidae Zittel, 1877

Subfamily Chonelasmatinae Schrammen, 1912

Genus *Chonelasma* Schulze, 1886

Chonelasma choanoides (Schulze & Kirkpatrick, 1910)

Material examined. Paralectotypes: BMNH 1910.10.28.46, R.V. 'Gauss', stn 72, NW of Winter Station, Antarctica, 01 Mar. 1903, 66º02'09"S, 89º38'E, 2450 m; ZMH S-2938, RV. 'Gauss', stn 69, NW of Winter Station, Antarctica, 24 Feb. 1903, 66º02'09"S, 89º38'E, 2725 m, ethanol; ANDEEP III material: SMF 10708, R.V. 'Polarstern', stn PS67/133-2, Weddell Sea, Antarctica, 16 Mar. 2005, 62°46.49'–46.38'S, 53°02.57'–03.50'W, 1584–1579 m, ethanol.

Description and remarks. Many small, fairly soft fragments of a probable single living specimen were obtained from the epibenthic sled at a single station. Spiculation conforms to that described in Reiswig and Mehl (1994). This species is widely distributed around Antarctica and throughout the Atlantic Ocean to Greenland; a symbiotic hydrozoan was noted on the ANDEEP III fragments, not previously mentioned in any of the extensive literature of this species. Janussen et al. (2004) reported this species from the Weddell Sea in their description of the ANDEEP II collections.

Order Lyssacinosida Zittel, 1877

Family Euplectellidae Gray, 1867

Subfamily Euplectellinae Gray, 1867

Genus *Acoelocalyx* Topsent, 1910

***Acoelocalyx brucei* Topsent, 1910**
(Fig. 1A)

Material examined: SMF 10530, ANDEEP III, R.V. 'Polarstern', stn PS67/102-11, Weddell Sea, Antarctica, 06 Mar. 2005, 65°35.40'–35.51'S, 36°29.00'–28.83'W, 4794–4797 m, ethanol.

Description and remarks. The single small specimen obtained by trawl was intact and in very good shape when retrieved; overall length 7.5 cm, body 1 cm long, stalk 4.5 cm long, and root ball 1.5 cm long (Fig. 1A). Spiculation is generally consistent with descriptions of Topsent (1910, 1913), and Tabachnick (2002a); microscleres are much smaller than Topsent originally indicated, but agree with measurements more recently given by Tabachnick (2002a)for the holotype. The ANDEEP III specimen is very important, being only the second known sample of this species. It has not been reported since its original description by Topsent (1910, 1913) from the 1903 'Scotia' collection, very close to the new site and from a similar depth.

Genus *Malacosaccus* Schulze, 1886

***Malacosaccus coatsi* Topsent, 1910**
(Figs. 1B, 2 & 3, Table 1)

Material examined: SMF 10702, ANDEEP III, R.V. 'Polarstern' stn PS67/102-11, Weddell Sea, Antarctica, 06 Mar. 2005, 65°35.40'–35.51'S, 36°29.00'–28.83'W, 4794–4797 m; ANDEEP III, SMF 10521, SMF 10703, SMF 10704, R.V. 'Polarstern', stn PS67/121-7, Weddell Sea, Antarctica, 14 Mar. 2005, 63°34.92'–34.65'S, 50°41.97'–41.68'W, 2616–2617 m.

Description: Specimens were collected from two trawl stations, a single large nearly intact cup torn from the missing stalk (Fig. 2A) from the first station and another specimen with stalk and root intact but with upper cup slightly damaged (Fig. 1B) and two smaller fragments from the second station. The first specimen is 91 mm tall, 102 mm in diameter with a wall up to 25 mm in thickness. The second specimen is a stalked cup, total height 495 mm, upper cup width 234 mm, stalk 258 mm long by 41 mm diameter, root ball 152 mm diameter. The external surfaces of the upper body of both specimens are heavily mud-laden and woolly in appearance; the atrial surfaces are penetrated by apertures of exhalant canals, 1–8 mm in diameter (Fig. 2A).

Megascleres of both specimens are were found to be essentially identical; only those of the first specimen (station 102-11) were examined in detail (measurements given in Table 1). Dermalia and atrialia are pinular hexactins (Figs. 2B, 3A) with scale-like, distal-pointed spines on the long, smoothly tapered, inflated pinular ray. All other rays are smooth and cylindrical, with rounded or parabolic tips. Principalia are very large hexactins (Fig. 3B) and pentactins (Fig. 3C), about equal in abundance. Their rays are smooth and cylindrical, terminating in rounded or slightly parabolic tips. Large triactins and stauractins are additionally present in the stalk of specimen 2; their rays are similar in form to the principalia of the body. No diactine megascleres are present and the only spines occurring are on the pinular ray of dermalia and atrialia.

Microscleres of both specimens include floricomes, discohexasters, and onychohexasters, but the two specimens differ in oxyhexasters, these being very abundant in the specimen from station 102-11, and absent in the specimen from station 121-7. Measurements of the former are given in Table 1. The relatively large oxyhexasters (Figs. 2C, 3F) have six short primary rays, each bearing 2–4 straight terminal rays which are

smooth in LM and seen to bear sparse, very small spines in SEM. The moderately abundant floricomes (Figs 2C, 3E & F) have six short primary rays, each of which bear 2–9 s-shaped terminals ending in typical eccentric heads bearing 4–8 short claws. Primary rays are sparsely spined in SEM and terminal rays are densely covered in small recurved spines which are evident in LM. Discohexasters (Figs. 2E, 3F) are floricoidal in form and often more slender, with six short primary rays each bearing 3–8 s-shaped terminal rays ending in complete discs with 4–8 marginal spines. They are ornamented like the true floricomes. Onychohexasters (Figs. 2F, 3F) are floricoid in form and very slender; they are difficult to find and often broken. Each of the six short primary rays carries 2–5 s-shaped terminal rays ending in a tuft of 3–5 perpendicular claws. Recurved spines are sparse on the primary rays and dense on the secondary rays. Rare

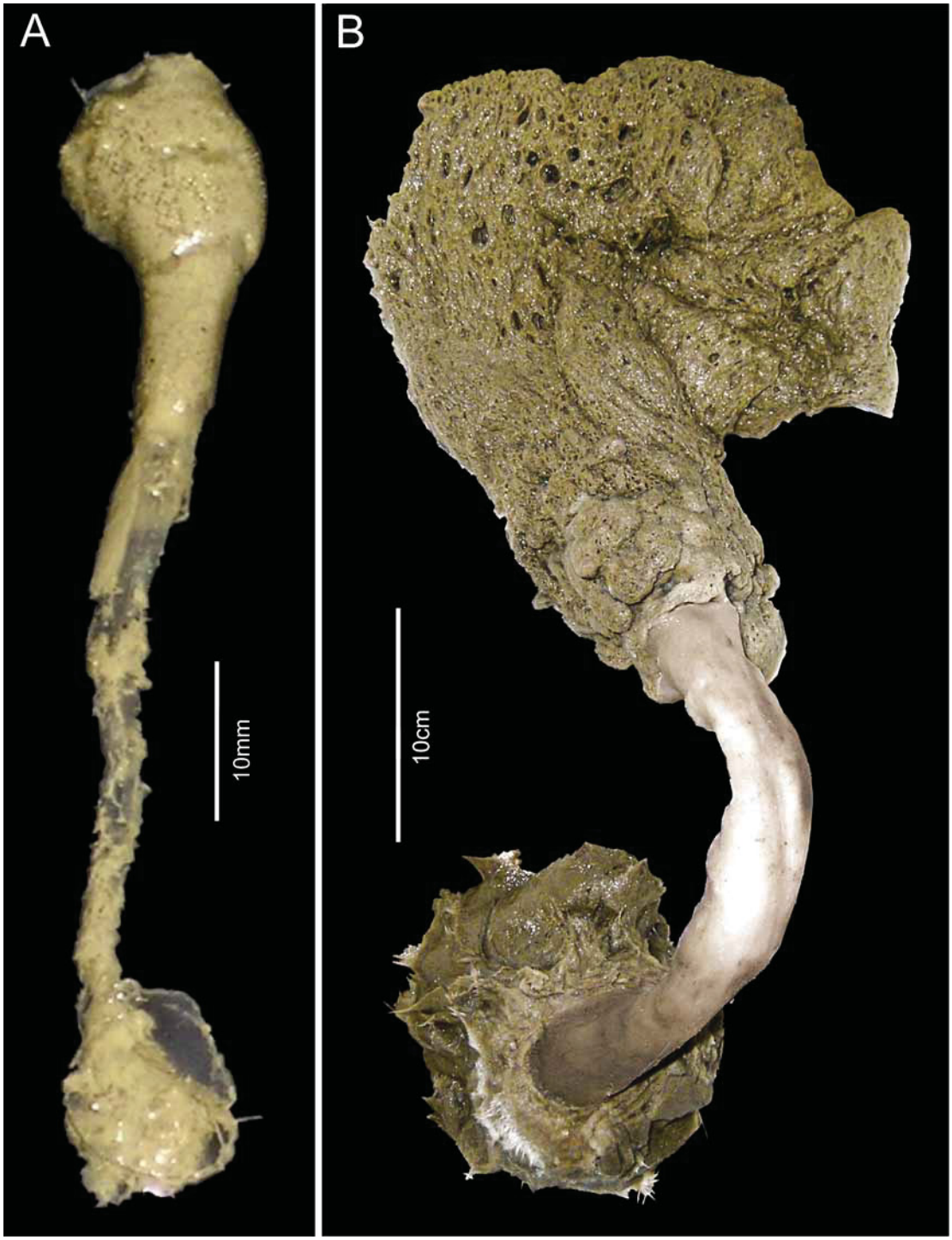

FIGURE 1. A. *Acoelocalyx brucei* (SMF 10530). B. *Malacosaccus coatsi* from stn PS67/121-7 (SMF 10521).

TABLE 1. Spicule dimensions of *Malacosaccus coatsi,* SMF 10702, from the Weddell Sea, Antarctica (dimensions in µm).

parameter	mean	st. dev.	range	n.
Pinular hexactin				
pinule ray length	395	24	318–441	75
pinule ray basal width	11.6	2.3	6.4–20.3	50
pinule ray greatest width	28.9	5.1	14.7–38.8	79
tangential ray length	331	44	204–431	63
tangential ray width	9.8	2.2	5.7–18.2	62
proximal ray length	1,185	152	861–1,661	37
proximal ray width	10.5	2.3	6.8–19.7	50
Large hexactin ray length	1,144	281	544–1,834	84
ray width	11.0	2.3	6.0–16.9	51
Large pentactin				
tangential ray length	1,361	311	730–2,094	53
tangential ray width	11.3	2.1	7.2–15.3	61
proximal ray length	892	195	514–1,350	44
proximal ray width	10.3	1.7	7.5–14.1	51
Oxyhexaster diameter	167	30	107–227	50
primary ray length	12.8	2.4	8.6–18.8	50
secondary ray length	72	14	47–101	50
Floricome diameter	114	12	92–137	50
primary ray length	11.5	1.6	8.0–15.3	50
secondary ray length	46.0	4.9	36.6–56.9	50
Discohexaster diameter	108	16	88–149	20
primary ray length	10.9	1.8	7.4–13.7	20
secondary ray length	43.0	7.3	30.0–61.5	20
Onychohexaster diameter	99	10	77–113	15
primary ray length	9.8	1.6	7.0–13.2	15
secondary ray length	39.8	4.8	28.5–47.7	15

abnormal variants include spiroxyhexasters (Fig. 3G) and bizarre crab-like oxyasters. No evidence of graphiocomes was found in either specimen. One spherical discohexaster (not figured), 58 µm in diameter, with about 10 straight terminal rays on each primary ray was found in the first specimen; it is considered likely to be foreign in origin.

Remarks: The ANDEEP III specimens are clearly assignable to Topsent's *Malacosaccus coatsi* in their possession of both pentactin and hexactin principalia and range of floricoidal microscleres. Although Topsent did not designate the discohexasters with tufts of spines at terminal ray ends as onychohexasters, he correctly described and figured them in his 1913 description. These specimens differ from *M. pedunculatus* Topsent, 1910, originally collected at the same location as *M. coatsi*, in their larger dermalia pinule rays, their possession of pentactin principalia and lack of spheric discohexasters. As *M. coatsi* is presently understood, oxyhexasters seem to be a variable spicule which is not correlated to geography but may be related to depth. They are present in low numbers in the original type specimen (2579 m, 16º34'W), absent in the EASIZ fragments (1540 m, 21º24'W) reported by Janussen et al. (2004), and absent in the western ANDEEP III specimen (2616 m, 50º41'W) but abundant in the eastern, deeper water specimen (4794 m, 36º33'W). Future

collected material may help reveal the pattern of oxyhexaster production in various portions of the *M. coatsi* population.

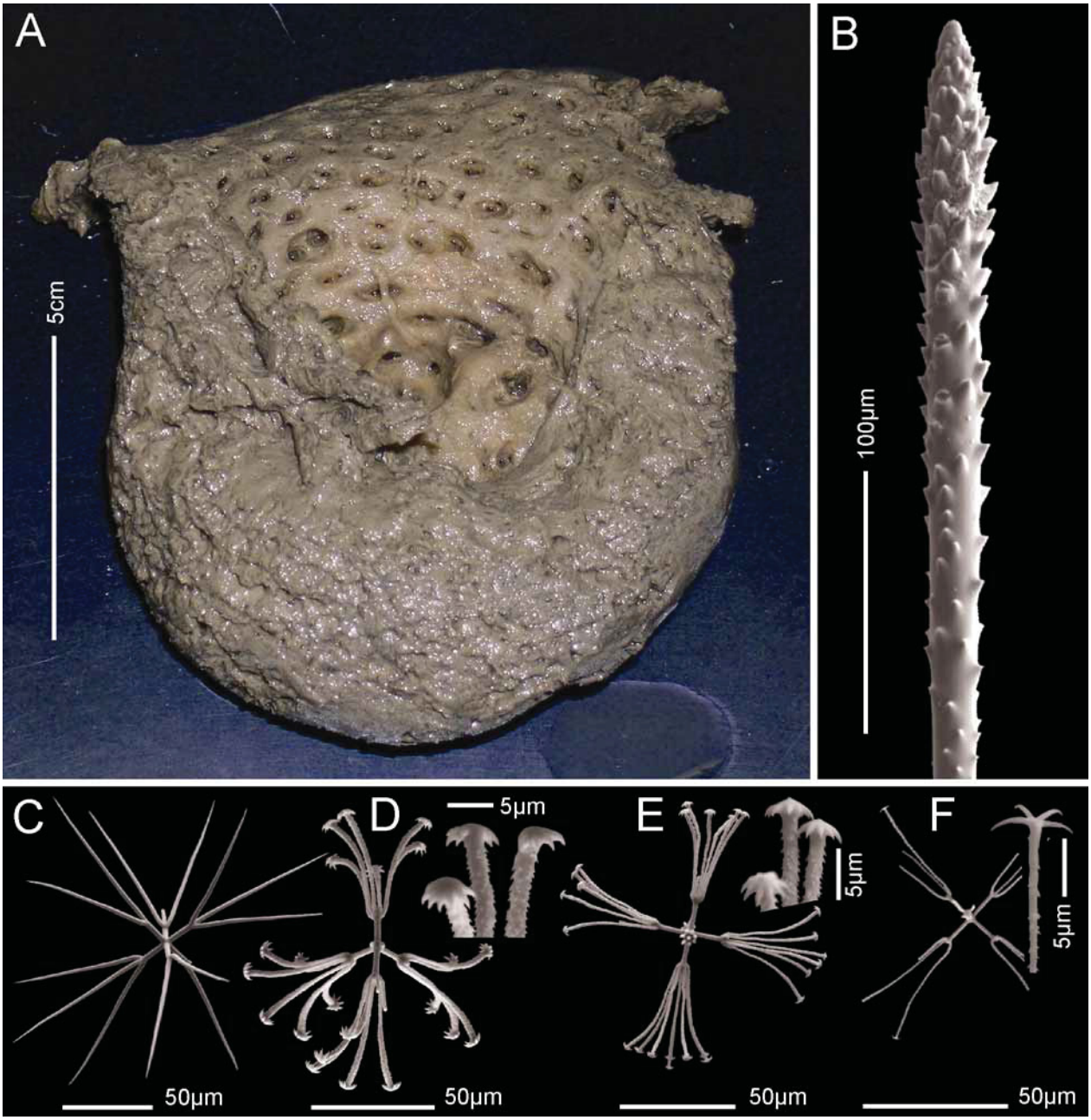

FIGURE 2. *Malacosaccus coatsi* from stn. PS67/102-11 (SMF 10702). A. View of upper body. B. Distal pinule ray of dermalium (SEM). C. Oxyhexaster (SEM). D. Floricome with tufts missing and enlargement of terminal ray tips (SEM). E. Floricoid discohexaster with enlargements of terminal ray tips (SEM). F. Broken onychohexaster with enlargement of terminal ray tip (SEM).

Family Rossellidae Schulze, 1885

Subfamily Lanuginellinae Gray, 1872

Genus *Lophocalyx* Schulze, 1887

***Lophocalyx profundum* n. sp.**
(Figs. 4 & 5, Table 2)

Material examined: Holotype, SMF 10524, ANDEEP III, R.V. 'Polarstern', stn PS67/080-6, Weddell Sea, Antarctica, 22 Feb. 2005, 70°40.23'S, 14°43.78'W to 70°40.42'S, 14°43.83'W, 3006–2978 m, ethanol. Paratypes: SMF 10605, and SMF 10604, same data

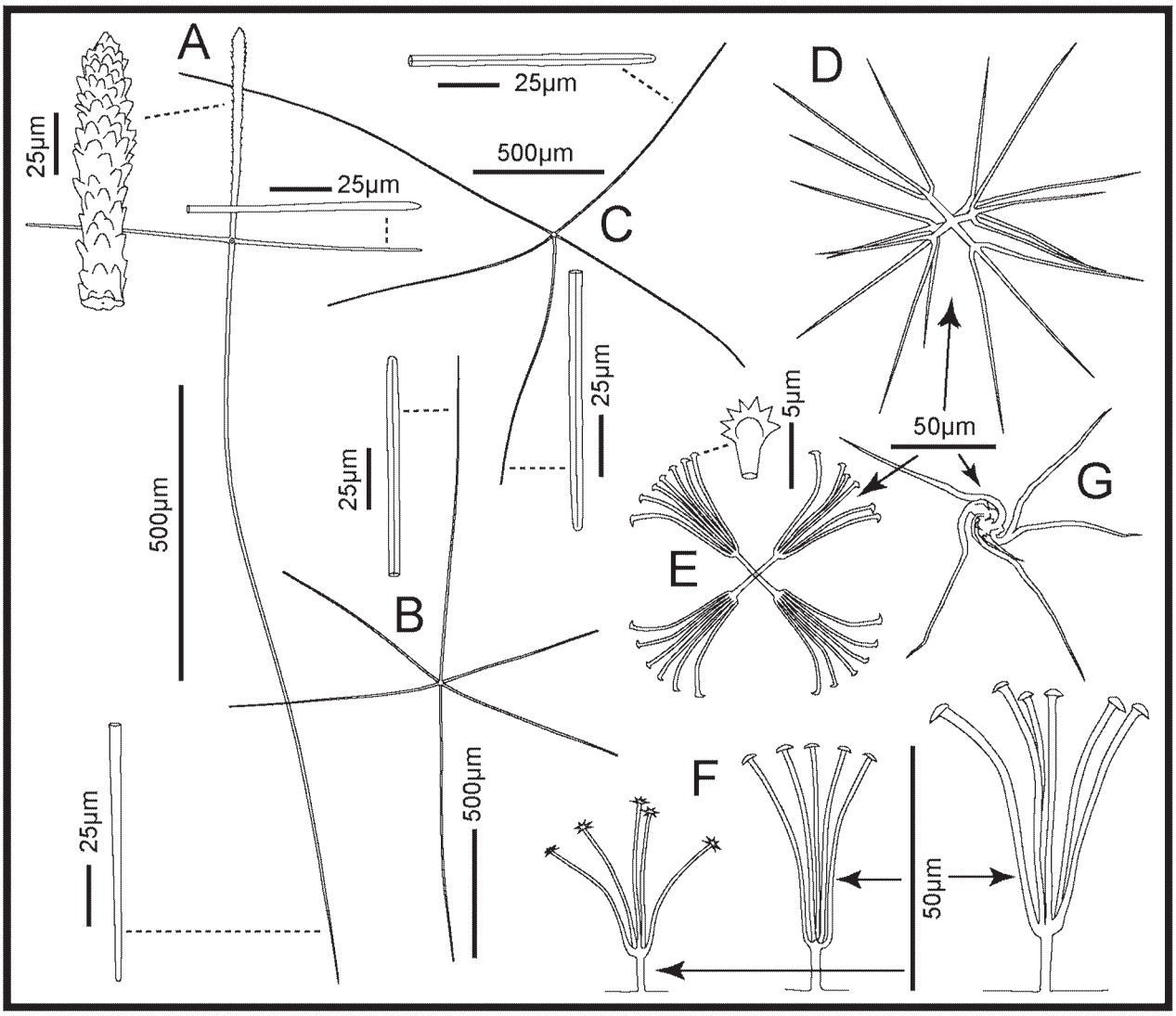

FIGURE 3. Spicules of *Malacosaccus coatsi* from stn. PS67/102-11 (SMF 10702). A. Dermal pinular hexactin and enlargements of three ray ends. B. Hexactine principalium with enlargement of ray end. C. Pentactine principalium with enlargements of tangential and proximal ray ends. D. Oxyhexaster. E. Floricome (two ray sets perpendicular to the page omitted) with enlargement of terminal ray tip. F. Series of one ray sets from floricome (right), floricoid discohexaster (center) and floricoid onychohexaster (left). G. Spiroxyhexaster (rare).

Description: All three specimens are small globular, nearly spherical forms (Figs 4A–C), 19–23 mm in diameter, with small terminal osculum 4–9 mm in diameter with smooth margins (without marginalia). Short basal extensions project from the lower margin, increasing contact with the substratum; attachment appears to be a combination of both direct (basiphytous) anchorage to small pebbles and insinuation of anchorate prostalia into sediments (lophophytous). All external surfaces carry prostalia projecting individually (not in tufts) up to 23 mm; these consist of a mixture of three spicule types: stout diactins, raised hypodermal anchorate pentactins, and raised regular hypodermal pentactins. Anchorate pentactins have not been found in the paratypes but since the distal ends of all prostalia are broken, they may well have been present in raised

position before collection. The atrial cavity is deep and narrow; the body wall is up to 6 mm in thickness. The general surface is smooth, tissues are soft but well supported by spicules, and the color is light brown (khaki). Spicule fusion does not occur in any of the specimens.

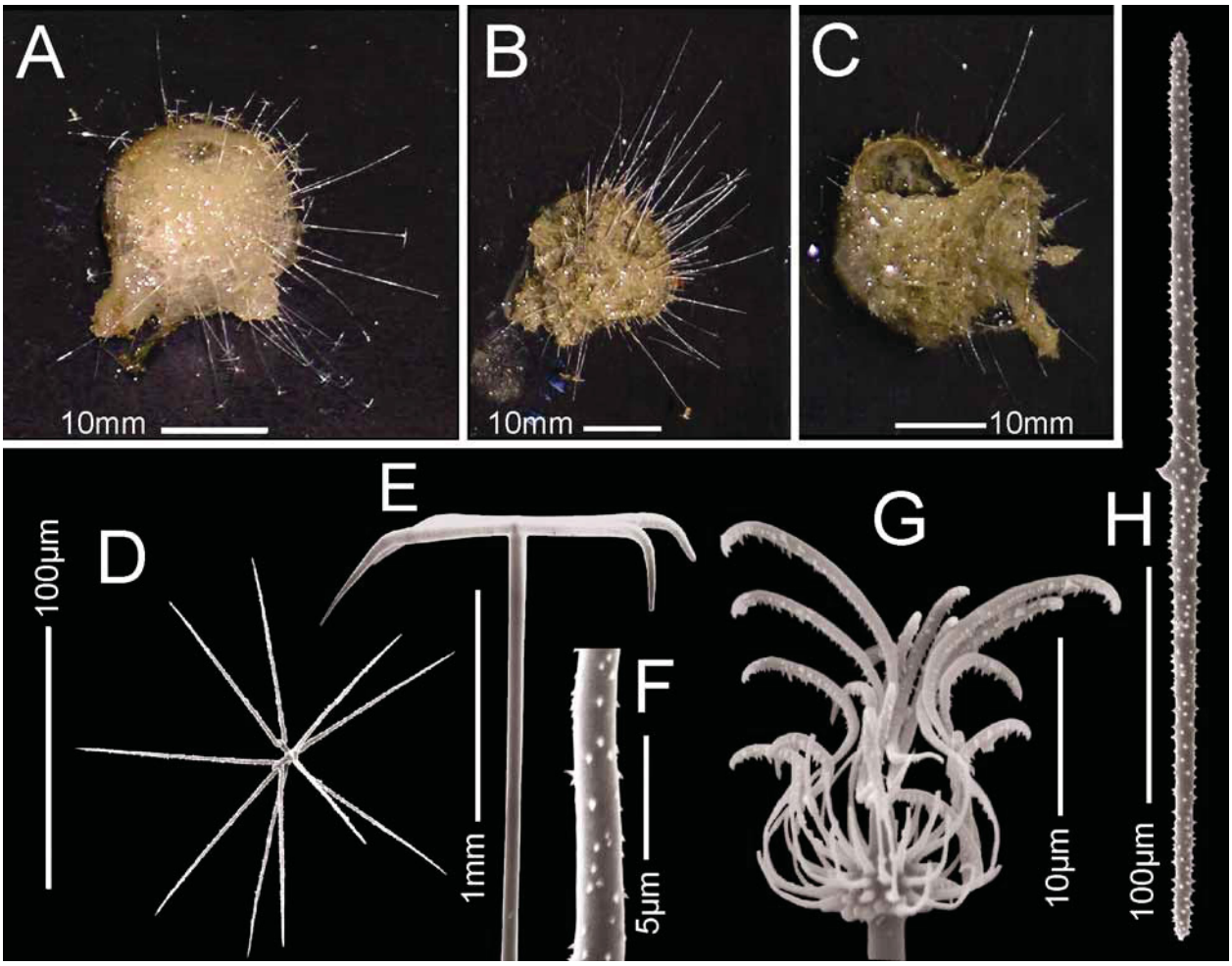

FIGURE 4. *Lophocalyx profundum*, n. sp . A. Holotype deck photo (SMF 10524). B. & C. Paratypes, deck photos. D. Oxyhexaster (SEM). E. Anchorate hypodermalium tip (SEM). F. Segment of oxyhexaster terminal ray (SEM). G. Terminal tuft of strobiloplumicome (SEM). H. Diactine dermalium (SEM). (All spicules from holotype).

Megascleres (dimensions in Table 2) consist of hypodermal (and prostal) anchorate pentactins, hypodermal (and prostal) regular pentactins, diactine dermalia, pinular hexactine atrialia, thick prostal and primary diactins, and thin choanosomal diactins. Anchorate hypodermalia (Figs. 4E, 5A) have tangential rays bent abruptly back from 30 to 90° near their mid-points; they are covered with fine spines (shagreen) but the proximal ray is smooth. Ray tips are parabolic-rounded or bullet-shape. Regular hypodermal (and prostal) pentactins (Fig. 5B) have straight to undulatory tangential rays; some are entirely smooth except for roughening at ray ends; other pentactins are entirely finely tuberculate. Dermalia are almost exclusively rough diactins (Figs. 4H, 5E), but a very few stauractins, triactins and monactins can be found amongst this spicule type; ray tips may be sharp-pointed, rounded, or inflated, depending upon spicule thickness; the central swelling is usually well developed with two alternate rays being developed to short stumps up to 20 µm long. Atrialia are sub-pinular hexactins (Fig. 5F) that lie embedded deep within the atrial tissues in subatrial position; the pinular ray is not bushy but distinguished from the other rays by its greater length, extent of spination, and curvature; these spicules are mostly smooth but all ray ends are rough and terminate in parabolic-rounded tips. Prostal and principal choanosomal diactins (Fig. 5C) are moderately thick, slightly curved, and entirely shagreened with larger spines developed near the ray ends; the ray tips are rounded with a

bare cap and they bear no distinct central swelling. Thin choanosomal diactins (Fig. 5D) are abundant smooth spicules with rounded to parabolic roughened tips and usually a slight swelling at the spicular center. They occur primarily in bundles.

TABLE 2. Spicule dimensions of *Lophocalyx profundum,* **n. sp.**, holotype, SMF 10524, from the Weddell Sea, Antarctica (dimensions in µm unless otherwise indicated).

parameter	mean	st. dev.	range	n.
Anchorate hypodermalia				
tangential ray length	958	189	610–1,463	54
tangential ray width	53.1	16.0	24.2–102.4	72
proximal ray length (mm)	6.36	2.36	0.39–13.64	17
proximal ray width	53.9	19.7	29.0–107.0	29
Regular hypodermalia				
tangential ray length	702	170	445–1,650	152
tangential ray width	33.8	6.7	20.8–50.3	50
proximal ray length (mm)	1.10	0.52	0.15–2.59	57
proximal ray width	32.6	6.9	12.4–52.8	59
Dermal diactin ray length	225	27	164–291	50
width	10.2	2.1	6.6–15.1	50
Atrial pinular hexactin				
pinular ray length	490	90	309–663	51
pinular ray width	23.9	5.7	11.5–39.4	66
tangential ray length	492	101	248–766	118
tangential ray width	26.1	5.1	15.0–35.8	50
proximal ray length	306	92	144–526	54
proximal ray width	22.7	4.9	12.5–32.6	61
Thick diactin length (mm)	12.27	3.56	8.17–14.65	3
width	65.0	9.8	35.1–79.9	20
Thin diactin length (mm)	3.07	1.12	1.46–5.97	50
width	14.4	5.0	5.5–31.5	50
Oxyhexaster diameter	141	16	108–182	50
primary ray length	7.1	1.5	4.8–11.9	50
secondary ray length	64.9	7.1	50.8–83.4	50
Plumicome diameter	59.4	5.1	49.5–69.9	50
primary ray length	11.7	1.3	9.6–15.0	50
long secondary ray length	22.2	2.1	16.6–27.2	50

Microscleres (dimensions in Table 2) consist of oxyhexasters, hemioxyhexasters, rare oxyhexactins, and strobiloplumicomes. Oxyhexasters and hemioxyhexasters are the most abundant microscleres (Figs. 4D & F, 5G); their short primary rays each bear 1–3 thin straight terminals; both primary and terminal rays are covered with very fine recurved thorns only visible with SEM; very rarely are terminals bent or curved; rare oxyhexactins occur among this spicule category. Strobiloplumicomes (Figs. 4G, 5H) are uncommon and usually broken; each short primary bears a small subterminal spherical swelling from which about 40 sigmoid terminal rays arise in 4–5 whorls, the terminals of each successively distal whorl being longer than those of the more proximal whorls. The terminals all bear two rows of sharp recurved thorns on the inner concave

surface of their distal halves, endowing this spicule type with enormous snaring capacity – when another spicule has been "grasped", they can only be separated by destruction.

Etymology: The species name, *profundum*, reflects the great depth from which this form has been collected.

Remarks: This new species possesses all of the characters defining the genus *Lophocalyx*. It differs from all ten previously known species, as summarized by Menshenina et al. (2007), in having diactins as the major dermal spicule. All other species have either stauractins, hexactins, or a combination of hexactins and pentactins as dermalia.

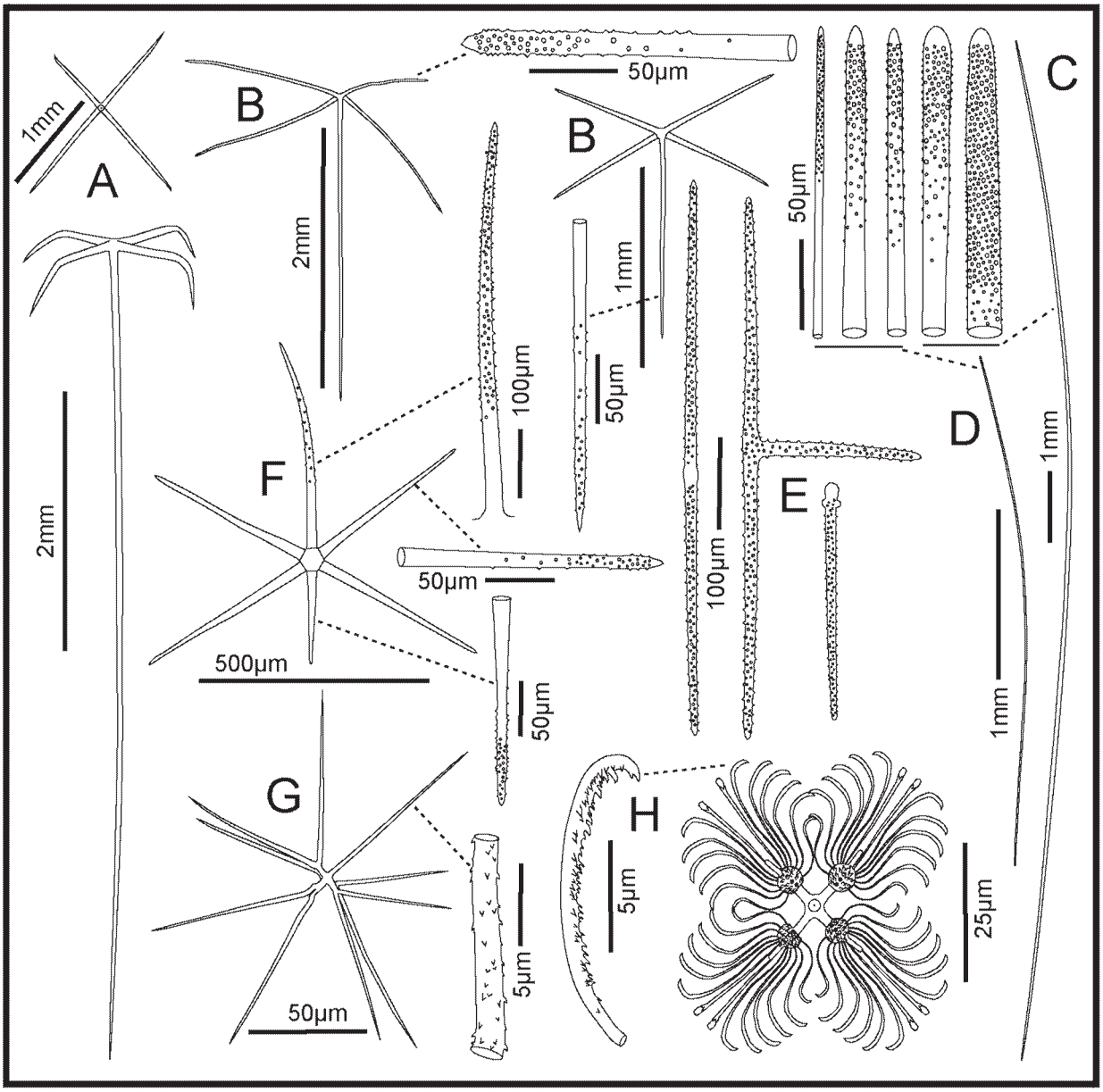

FIGURE 5. Spicules of *Lophocalyx profundum*, **n. sp.** holotype (SMF 10524). A. Anchorate hypodermal pentactin in end and side views. B. Two regular hypodermal pentactins with enlargements of tangential and proximal ray ends. C. Thick diactin with enlargements of ends. D. Thin choanosomal diactin with enlargements of ends. E. Diactine, triactine and monactine dermalia. F. Pinular hexactine atrialium with enlargements of ray ends. G. Oxyhexaster with enlargement of terminal ray segment. H. Strobiloplumicome in optical section with rays perpendicular to the page omitted, with enlargement of a terminal ray end.

***Lophocalyx topsenti* n. sp.**
(Figs. 6 & 7, Table 3)

Material examined: *Lophocalyx topsenti* **n. sp.**, Holotype, SMF 10606, ANDEEP III Exped., R.V. 'Polarstern', stn PS67/142-6, Weddell Sea, Antarctica, 18 Mar. 2005, 62°09.93'S, 49°30.47'W to 62°09.80'S, 49°30.59'W, 3403–3404 m, ethanol. Paratype: RSM 1921.143.1389, Scottish National Antarctic Exped., R.V. 'Scotia', stn 313, Weddell Sea, Antarctica, 18 Mar. 1903, 62°10'S, 41°20'W, 3247 m, ethanol (reported as *Calycosoma validum* by Topsent, 1910, 1913). Comparative material: *Calycosoma validum*: holotype, USNM 04761, U.S.F.C.S. 'Albatross', stn 2573, George's Bank, SE of Massachusetts, USA, 02 Sep. 1885, 40º34'18"N, 66º09'W, 3186 m, ethanol.

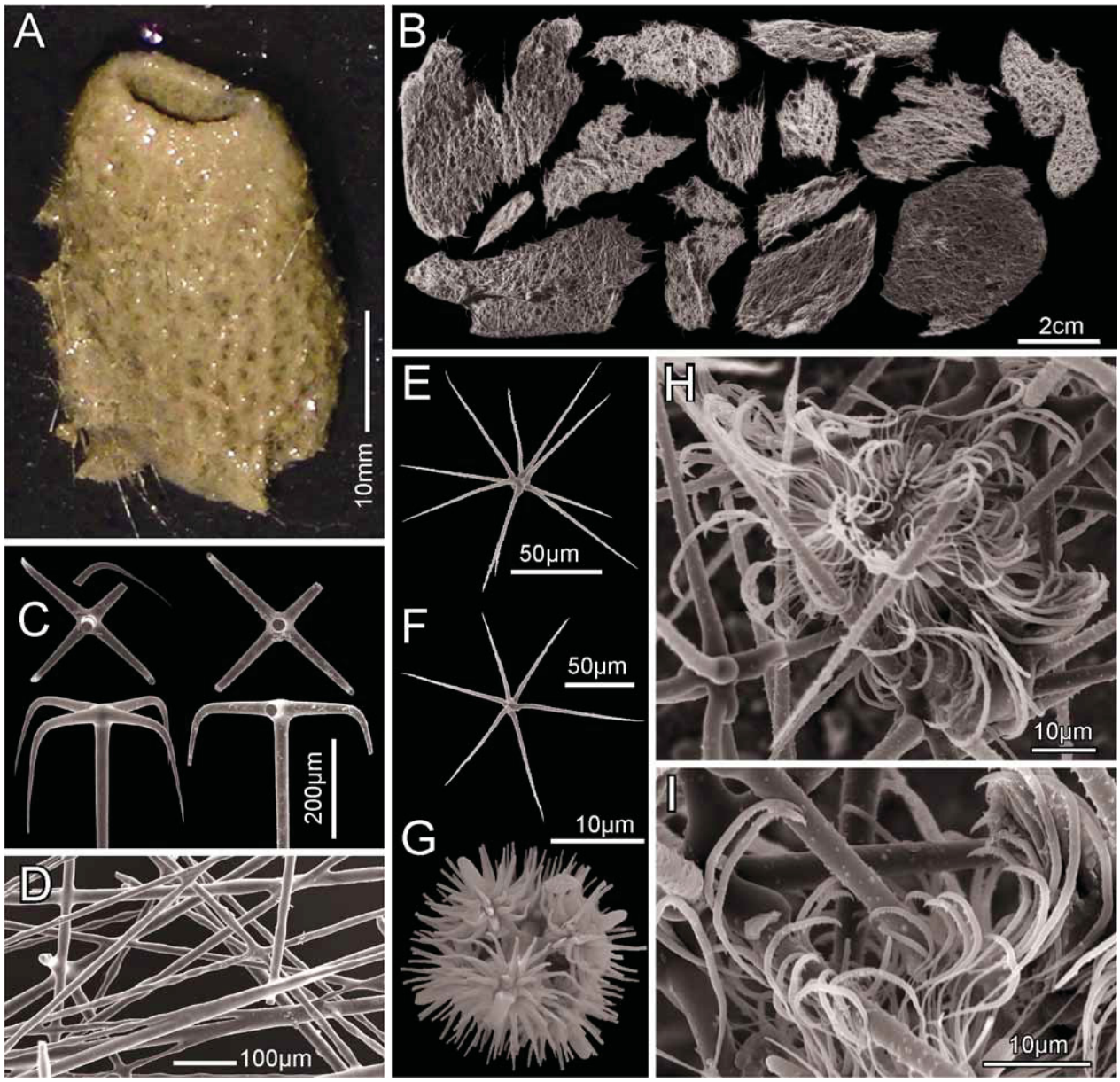

FIGURE 6. *Lophocalyx topsenti*, **n. sp.** A. Holotype deck photo (SMF 10606). B. Paratype, part of the fragments (RSM 1921.143.1389). C. Anchorate hypodermalia from the holotype (left) and paratype (right). D. Fusion of megascleres of the paratype. E. Oxyhexaster (SEM). F. Oxyhexactin (SEM). G. Strobiloplumicome centrum (SEM). H. Whole strobiloplumicome ensnared in oxyhexasters (SEM). I. Magnified view of terminal rays of strobiloplumicome (SEM). (All microscleres from holotype).

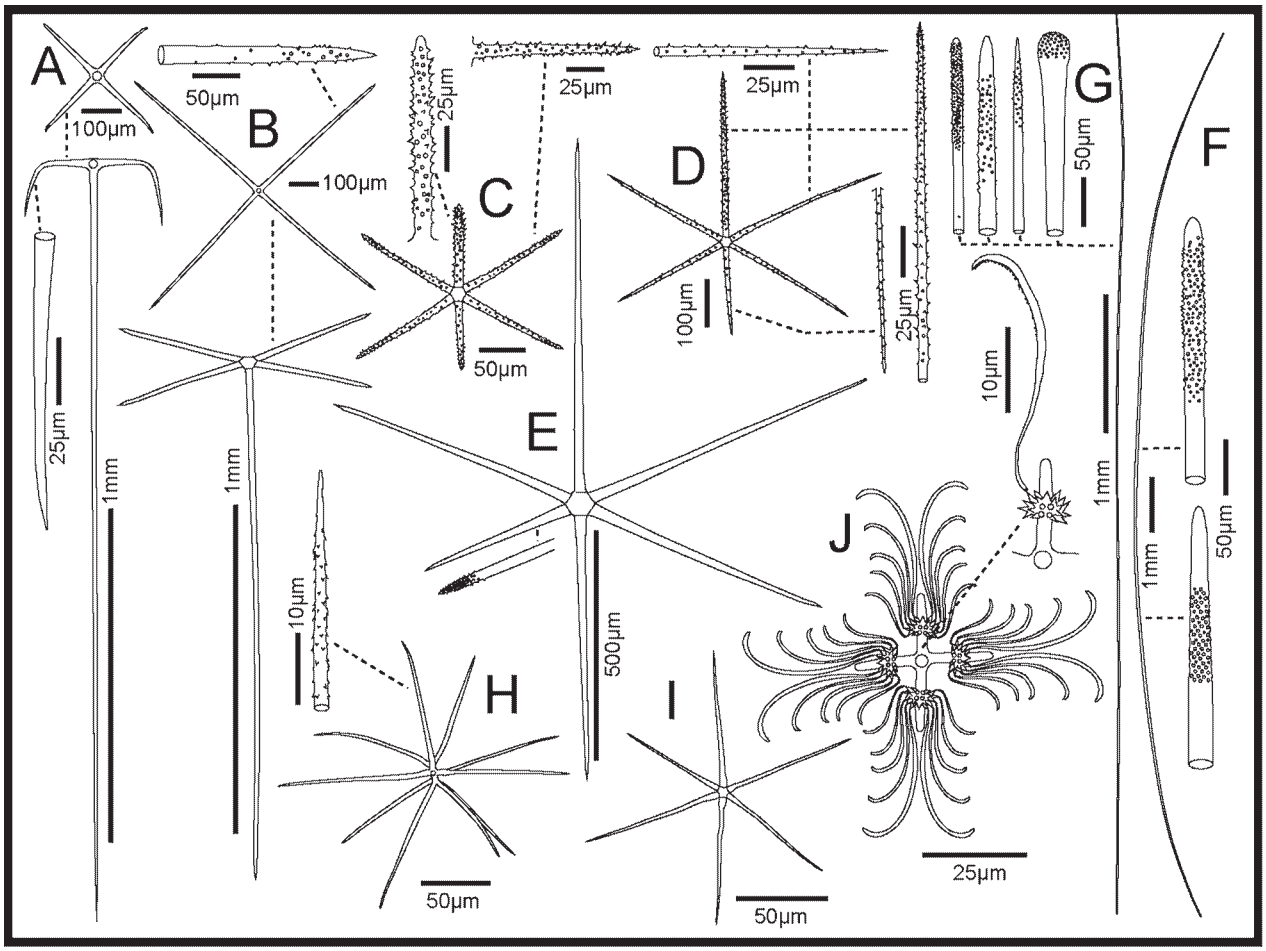

FIGURE 7. Spicules of *Lophocalyx topsenti*, **n. sp.** holotype (SMF 10606). A. Anchorate hypodermal pentactin in end and side views with magnified tangential ray tip. B. Regular hypodermal pentactin in end and lateral view with enlargement of tangential ray end. C. Pinular hexactine dermalium with enlargements of pinular and tangential rays. D. Pinular hexactine atrialium with enlargements of pinular, tangential and proximal ray ends. E. Large choanosomal hexactin with alternate forms of short ray. F. Thick diactin with enlargments of two ends. G. Thin choanosomal diactin with enlargements of variety of ends. H. Oxyhexaster with enlargement of a terminal ray end. I. Oxyhexactin. J. Strobiloplumicome in optical section with rays perpendicular to the page omitted, with enlargement of one primary and terminal ray.

Description: The holotype of the new species, when inspected in June 2006 before partial dissection, was a small, intact, tubular sponge 31 mm tall and 20 mm in diameter, with a terminal osculum 9 mm in diameter, without marginalia, with wall thickness of 2 mm (Fig. 6A). Several prostal diactins project obliquely upwards up to 9 mm from the body surface but hypodermal spicules are not raised to form a veil; groups of broken basalia project from irregular lobes of the lower body surface. The lateral surface is generally smooth to the naked eye, but, when magnified, is irregular with low conules; entrances to inhalant canals are evident through the surface lattice. The sponge is soft and pliable; color is olive brown, the same as the bottom "green-mud" substrate.

The paratype, when surveyed February – May 1996, consisted of 17 wet fragments, 0.5–3 mm in thickness, the remnants of the original six fragments reported by Topsent (1913), as probably stemming from a single large cup-shaped specimen (Fig. 6B). Both surfaces of most fragments retain the fine spicule lattice spanning over the apertures of inhalant and exhalant canals as outlined by the choanosomal diactin bundles. Intact and broken diactins projected from one surface of most fragments, but hypodermalia were not found above the lattices of free spicules. All fragments were somewhat stiff and brittle, due to extensive but tenuous fusion of megascleres (Fig.6D).

TABLE 3. Spicule dimensions of *Lophocalyx topsenti,* **n. sp.**, from the Weddell Sea, Antarctica (dimensions in µm unless otherwise noted).

	Holotype SMF 10606				Paratype RSM 1921.143.1389			
parameter	mean	st. dev.	range	n	mean	st. dev.	range	n.
Anchorate hypodermalia								
tangential ray length	242	38	146–292	25	196	22	149–256	77
tangential ray width	21.6	5.4	12.8–32.1	25	27.8	3.6	16.8–33.6	30
proximal ray length (mm)	1.62	0.59	0.86–2.47	18	*	*	*	*
proximal ray width	25.0	4.8	13.9–33.9	25	28.6	4.0	16.8–37.3	56
Regular hypodermalia								
tangential ray length	592	33	354–1,156	25	636	133	457–1,534	122
tangential ray width	23.2	3.7	17.1–36.9	25	25.5	4.2	14.1–33.6	37
proximal ray length (mm)	1.24	0.19	0.93–2.05	50	1.32	0.32	0.78–2.67	46
proximal ray width	24.3	3.2	18.2–34.6	25	26.3	3.9	17.9–34.2	27
Dermal pinular hexactin								
distal pinular ray length	107	24	71–160	25	122	25	66–185	91
ray width	9.6	1.2	6.9–11.8	25	12.3	1.8	9.9–15.8	25
tangential ray length	132	17	100–162	25	143	1.8	99–181	131
ray width	7.7	1.5	5.4–11.8	25	11.9	1.9	8.2–16.3	28
proximal ray length	87	15	68–112	25	99	20	34–143	80
ray width	8.0	1.3	5.9–10.9	25	11.6	1.8	8.0–16.0	25
Atrial pinular hexactin								
distal pinular ray length	396	165	105–687	49	337	170	99–736	50
ray width	13.0	5.2	5.1–24.5	56	13.6	4.4	8.2–27.3	32
tangential ray length	401	152	124–759	66	312	151	120–613	71
ray width	14.5	5.5	5.8–28.8	64	14.1	4.6	7.5–24.0	43
proximal ray length	320	261	70–865	50	214	290	57–1,042	50
ray width	12.7	4.5	4.8–21.5	55	12.3	4.5	5.9–23.9	47
Large principal hexactin								
ray length	709	165	502–911	7	1,098	424	261–2,824	108
ray width	25.9	4.1	21.2–32.0	7	33.2	4.2	21.2–41.2	30
Thick diactin length (mm)	9.8	2.5	7.9–18.5	16	15.9	6.1	6.6–33.0	28
width	39.5	14.1	24.8–76.4	28	75	33	23–140	134
Thin diactin length (mm)	3.1	1.1	1.2–5.5	27	4.9	2.2	1.7–9.4	30
width	12.6	3.7	6.5–20.9	25	13.8	3.8	6.7–24.0	51
Oxyhexaster diameter	170	12	152–197	25	151	18	64–193	100
primary ray length	5.3	0.9	3.3–6.7	25	6.4	1.2	3.9–10.0	32
secondary ray length	80.0	5.8	70.1–94.9	25	71.5	6.7	55.0–84.6	33
Plumicome diameter	71.6	7.6	51.3–82.7	25	65.3	8.5	43.2–82.8	110
primary ray length	13.2	1.5	10.2–15.8	25	14.0	1.1	11.2–18.2	101
secondary ray length	27.5	3.8	16.7–32.0	25	23.8	4.1	13.0–33.6	101

* no intact spicules of this type found

Megascleres (dimensions given in Table 3) consist of hypodermal anchorate pentactins, hypodermal regular pentactins, pinular hexactine dermalia, pinular hexactine atrialia, large choanosomal hexactins and thick choanosomal diactins as principalia (and as lateral prostalia for the diactins), and thin choanosomal diactins. Anchorate hypodermalia (Figs. 6C, 7A) are generally smooth with the crucially-arrayed tangential rays bent abruptly back 70–90° near their mid-points; ray tips are parabolic-rounded or bullet-shape and only the proximal ray tip is sometimes roughened near its end. Regular hypodermal pentactins (Fig. 7B) have straight, crucially-arrayed, tangential rays, smooth except for roughening at ray ends; neither these nor the anchorate forms are erected above the lateral surfaces. Occasional hypodermalia (Fig. 7B) are mixtures of the regular and anchorate types, with some straight rays and some shorter bent rays. Dermalia (Fig. 7C) are almost exclusively pinular rough hexactins with the distal ray differing from the others in thickness and density and size of its proclined spines; the pinular ray is generally shorter than the tangentials but longer than the proximal ray. The pinular ray tip is cylindric with a blunt tip while the other rays are tapered and end in sharply pointed tips. Atrialia (Fig. 7D) are rough pinular hexactins of much larger size range and slighter spination than the dermalia; in smaller forms the distal pinular ray (extending into atrial cavity) is the longest ray; in larger spicules of this type the proximal ray may be increased disproportionately and become larger than all other rays, while spination of the entire spicule is reduced or entirely lost. Large choanosomal hexactins (Fig. 7E) with straight rays sometimes have one very short and distally heavily spined ray. Thick diactins (Fig. 7F) serve as primary choanosomal and prostal spicules; they are slightly curved, and smooth except for fine spination just before the smooth rounded or bullet-shape spicule tips; they have no swelling at the spicule center. Occasional orthodiactins or L-form thick diactins occur. Thin choanosomal diactins (Fig. 7G) occur in bundles; they are mostly smooth, with rounded to parabolic and occasionally inflated roughened tips and usually a slight swelling at the spicular center.

Microscleres (dimensions given in Table 3) consist of oxyhexasters, hemioxyhexasters, rare oxyhexactins, and strobiloplumicomes. Oxyhexasters and hemioxyhexasters (Figs. 6E, 7H) are the most abundant microscleres; their short primary rays each bear 1–3 thin straight terminals; the thick primary rays are smooth while the terminal rays are covered with very fine recurved thorns detectable in LM; rare oxyhexactins of the same size occur among this spicule category (Figs. 6F, 7I). Strobiloplumicomes (Figs. 6G–I, 7J) are very common only in dermal and atrial surface tissues; primary rays bear a subterminal spherical inflation from which originate 3–5 whorls of sickle-shaped terminal rays of a series of different lengths, each of which is ornamented with two rows of spines on their distal concave (inner) surface; the pegs of the primary rays extending beyond the swelling are smooth and terminate in rounded tips.

Etymology: The species is named in honor of the eminent spongologist, Professor Emile Topsent, who originally described the paratype.

Remarks: Topsent (1910, 1913) was very clear in his original description of the 'Scotia' specimen, that it differed from Schulze's *Calycosoma validum* in several aspects, the most notable being the presence of anchorate hypodermalia (absent in *C. validum*) and the absence of pentactine dermalia (abundant in *C. validum*). He nonetheless attributed these features to malformations and individualistic variation, and assigned the Antarctic specimen to *C. validum*. Barthel and Tendal (1994) accepted these obvious discrepancies and re-diagnosed *Calycosoma* and *C. validum* to include features of both the N Atlantic and Antarctic specimens. Tabachnick (2002b) was the first reviewer to act in moving Topsent's Antarctic specimen from *Calycosoma* to *Lophocalyx*, but suggested no species name. Menshenina et al. (2007), in their re-diagnoses of *Calycosoma* and *Lophocalyx*, noted once again the clear differences between Schulze's description of *C. validum* and Topsent's description of the Antarctic specimen and again stated that Topsent's specimen should be transferred to *Lophocalyx* pending re-analysis of the *C. validum* type specimen. We have here examined both Schulze's type specimen of *C. validum* and Topsent's original Antarctic specimen, as well as a new specimen of *Lophocalyx* from the Weddell Sea. We verify that the differences between *C. validum* and Topsent's specimen are as repeatedly noted. There are no material differences between the new ANDEEP III specimen and Topsent's original Antarctic specimen, except for megasclere fusion which is absent in the former and

extensive, but tenuous, in the latter. We chose to designate the new specimen as holotype of the new species because it was complete and intact, although the smaller of the two, and designate Topsent's specimen, although the larger specimen, as paratype because it was fragmentary and severely damaged.

No single feature distinguishes the new species, *L. topsenti,* from the other members of the genus. Its pinular dermal hexactins separate it from the group with all or most dermalia as stauractins, *L. philippinensis* (Gray, 1872), *L. spinosa* Schulze, 1900, and *L. sululanus* Ijima, 1927, and from *L. moscalevia* Tabachnick, 1988, which has partly dermal pentactins. It differs from *L. biogassi* and *L. oregoni*, both of Menshenina et al., 2007, in having no pentactin atrialia. It differs from *L. pseudovalida* Menshenina et al., 2007 in the much larger size of its choanosomal hexactins, 0.26–2.84 mm versus 0.14–0.53 mm in the latter. It differs from *L. atlantiensis* and *L. brasiliensis*, both Menshenina et al., 2007, in form of its main oxyhexaster microscleres and the strongly reflected tangential rays of the anchorate hypodermalia which are only slightly or gradually recurved in those species. Finally, it clearly differs from *L. profundum*, described above, in having hexactine rather than diactine dermalia.

Subfamily Rossellinae

Genus *Bathydorus* Schulze, 1886

***Bathydorus spinosus* Schulze, 1886**
(Fig. 8)

Material examined: all ANDEEP III, SMF 10526, SMF 10526a, & SMF 10526b, SMF 10707, R.V. 'Polarstern', stn PS67/102-11, Weddell Sea, Antarctica, 06 Mar. 2005, 65º35.40'–35.51'S, 36°29.00'–28.83'W, 4794–4797 m, ethanol.

Description and remarks: Three specimens and fragments obtained from a single station all correspond well with the original description of *Bathydorus spinosus*. The best specimen is a thin walled funnel 88 mm tall, 145 mm wide when flattened, with a distinct marginal fringe of large diactins projecting 8 mm (Fig. 8). Spiculation of all specimens conforms to the simple pattern known for the species, with oxyhexasters as the only microscleres. It has been collected earlier from the Weddell Sea as reported by Janussen et al. (2004), and its wider Antarctic distribution has been reported by Barthel and Tendal (1994).

FIGURE 8. *Bathydorus spinosus* (SMF 10526) deck photograph.

Genus *Caulophacus* Schulze, 1885

Subgenus *Caulophacus (Caulodiscus)* Ijima, 1927

***Caulophacus (Caulodiscus) valdiviae* Schulze, 1904**

Material examined: SMF 10528/10607, ANDEEP III Exped., R.V. 'Polarstern', stn PS67/059-10, Weddell Sea, Antarctica, 15 Feb. 2005, 67°30.37'S, 0°03.74'E to 67°30.27'S, 0°04.34'E, 4648 m, ethanol.

Description and remarks. Seven fragments, probably from a single sponge, were obtained at a far eastern station of the Weddell Sea along with a fragment of one other caulophacid. Included is part of the upper stalk with lower body attached, 68 mm long by 9.6 mm diameter at its mid-waist. The largest upper body part is a sheet, 63 by 64 mm in horizontal dimensions, with a maximum thickness of 6 mm. Spiculation of six of the fragments are identical, including typical dermal and atrial pinular pentactins and hexactins, hypodermal pentactins with coarse spination on the proximal areas of all rays, principal diactins, and smooth choanosomal hexactins. Microscleres consist mainly of discohexactins with very rough rays and onychohexasters with relatively long primary rays, 19.8 (15.5–29.2) µm in length, each bearing five terminal rays, 22.5 (18.8–25.5) µm in length. This feature, following the key provided in Janussen et al. (2004:1870) allows unambiguous assignment of these fragments to *C. (Caulodiscus) valdiviae*, a species known from Antarctic waters off Enderby Land (Schulze, 1904) and possibly from Bellingshausen Sea (Barthel & Tendal, 1994). The seventh fragment has all of the spicules common to the other six, with addition of numerous oxyhexasters, unknown in this species. It is concluded that these are foreign intrusions from other specimens collected in the same trawl and that this fragment belongs to the same species and probably the same original specimen as the other six fragments. This report is the first record of occurrence of *C. (Caulodiscus) valdiviae* in the Weddell Sea region.

Subgenus *Caulophacus (Oxydiscus)* Janussen, Tabachnick & Tendal , 2004

***Caulophacus (Oxydiscus) weddelli* Janussen, Tabachnick & Tendal , 2004**
(Fig. 9)

Material examined: SMF 10527, ANDEEP III Exped., R.V. 'Polarstern', stn PS67/094-11, Weddell Sea, Antarctica, 02 Mar. 2005, 66°38.05'S, 27°05.90'W to 66°38.10'S, 27°05.46'W, 4893–4894 m, ethanol.

Description and remarks: The second known specimen of this species is nearly complete in its upper part, but is lacking most of the stalk (Fig. 9A). It is a stalked funnel, similar in form to the type specimen collected in 2002 on the ANDEEP II Expedition (Janussen et al., 2004), but much larger, 201 x 136 mm. Spiculation is identical to that of the type material, with the same dermal pinule (Fig. 9B), but with addition of a few onychohexaster microscleres (Fig. 9C). The new collection location is 446 km southwest of the type location at a similar depth.

***Caulophacus* sp.**

Material examined: SMF 10608, ANDEEP III Exped., R.V. 'Polarstern', stn PS67/059-10, Weddell Sea, Antarctica, 15 Feb. 2005, 67°30.37'S, 0°03.74'E to 67°30.27'S, 0°04.34'E, 4648 m, ethanol; SMF 10609, ANDEEP III Exped., R.V. 'Polarstern', stn PS67/142-6, Weddell Sea, Antarctica, 18 Mar. 2005, 62°09.93'S, 49°30.47'W to 62°09.80'S, 49°30.59'W, 3403–3404 m, ethanol.

Description and remarks: Two additional partial specimens, both stalks, attributable to *Caulophacus*, are inadequate to place more definitely. The first, from station PS67/059-10, collected along with *C.*

(Oxydiscus) weddelli, is a small stalk, 91 mm long, 2.7 mm diameter at its narrowest point, and 7.2 mm at its slightly inflated upper end. It is a hollow tube composed of diactins thoroughly fused by synapticula, characteristic of *Caulophacus* stalks. Associated with it are a few slightly pinular spiny hexactins and pentactins as surface spicules, with ray lengths of 100–250 µm. The only microscleres present are oxyhexasters along with hemioxyhexasters and oxyhexactins, 100–160 µm in diameter. Spiculation is thus similar to *Bathydorus subtilis*, but no specimens of that species were recovered from that station and such a fused stalk is not known from that species. The combination of stalk of fused diactins and spicules suggest this might be a new form of *C. (Caulophacella)* but the condition of the specimen is too poor to base a taxonomic description upon it. For now it is best designated as *Caulophacus* sp., but it suggests an interesting taxon is yet to be discovered in this area.

The second specimen from station PS67/142-6 consists of fragments of a larger stalk. It consists of diactins thoroughly fused by synapticula and contains a few loose spiny hexactins. It is almost certainly a *Caulophacus*, but cannot be attributed to any subgenus or species on the basis of its constituents.

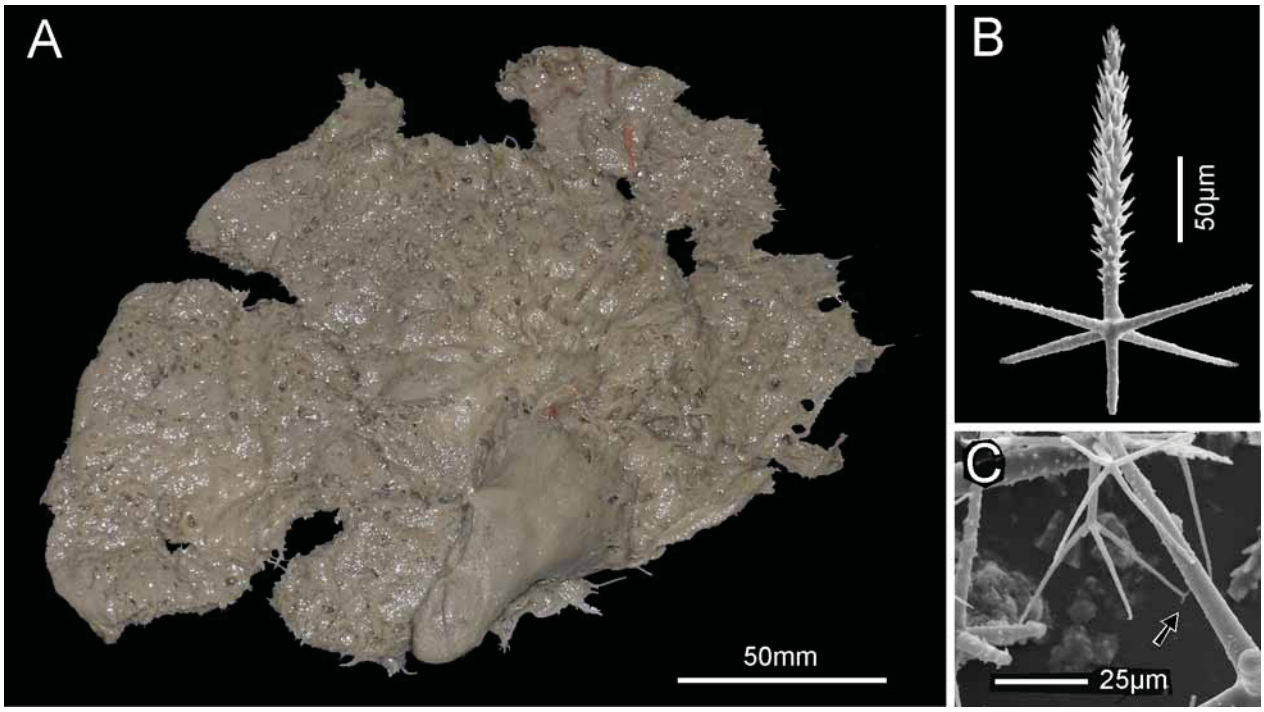

FIGURE 9. *Caulophacus (Oxydiscus) weddelli* (SMF 10527). A. Deck photograph. B. Dermal pinule (SEM). C. Microsclere with onychoid tip (arrow) (SEM).

Genus *Rossella* Carter, 1872

***Rossella racovitzae* Topsent, 1901**
(Fig. 10A)

Material examined: All from ANDEEP III Exped., Weddell Sea, Antarctica, SMF 10610a, and SMF 10610b, R.V. 'Polarstern', stn PS67/074-7, 20 Feb. 2005, 71°18.48'–18.40'S, 13°58.55'–58.14'W, 1055–1047 m, ethanol; SMF 10705, R.V. 'Polarstern', stn PS67/151-1, 20 Mar. 2005, 61°45.46'S, 47°07.57'W to 61°45.34'S, 47°07.78'W, 1181–1188 m, ethanol.

Description and remarks: Four specimens of this species were collected on the ANDEEP III Expedition. The two from station PS67/074-7 are large barrels, 28.7 cm tall by 15.9 cm flattened diameter and 30.7 cm tall by 17.7 cm flattened diameter, with strong 6 mm-tall conules on outer surface and few prostalia emanating

from the conule summits. The two specimens from station PS67/151-1 are a small conic tube, 54 mm tall by 22 mm upper diameter, and a small sac 52 mm tall by 34 mm maximal diameter, both with proportionately large prostalia projecting up to 32 mm from sides and oscular margins. Conules are not present on the small tubular form but very slight conules are evident on the small sac specimen. Although calycocomes are rare in these specimens, they agree in all morphologic features and other spicule details with the descriptions of the common Antarctic species, *R. racovitzae* by Topsent (1901, 1917), Burton (1929), Koltun (1976) and Barthel and Tendal (1994). Since the anisodiscohexasters have been generally poorly rendered in previous works, a first scanning electron micrograph of this spectacular spicule is provided (Fig. 10A) for comparison with those of other rossellid sponges. This species has been reported from ANDEEP II and other recent collections from the Weddell Sea (Janussen et al. 2004). It is circumantarctic in distribution, occurring at depths of 20–2012 m.

***Rossella nuda* Topsent, 1901**
(Fig. 10B)

Material examined: All from ANDEEP III Exped., Weddell Sea, Antarctica, SMF 10611a, SMF 10531, SMF 10612, SMF 10602 (3 specimens), SMF 10603, SMF 10706, R.V. 'Polarstern', stn PS67/074-7, 20 Feb. 2005, 71°18.48'–18.40'S, 13°58.55'–58.14'W, 1055–1047 m, ethanol; SMF 10600, PS67/133-2, Weddell Sea, Antarctica, 16 Mar. 2005, 62°46.49'–46.38'S, 53°02.57'–03.50'W, 1584–1579 m, ethanol.

Description and remarks: Fourteen specimens assignable to *Rossella nuda* were obtained on the ANDEEP III Expedition. These are mostly small sac-like forms, 26 to 93 mm in length, with smooth surfaces covered by long projecting prostalia. They agree in both morphology and spiculation with previous descriptions of *R. nuda* (Topsent, 1901; Burton, 1929, 1932; Barthel & Tendal, 1994). Since the anisodiscohexasters of this species have never been well illustrated, an SEM (Fig. 10B) is provided to document their fine structure and to serve for comparison with those of other rossellids. This species is another very well known member of the Antarctic benthic fauna, with distribution including the Bellingshausen Sea, South Georgia Island, and from eastern Weddell Sea to the Ross Sea. It had previously been recorded from depths of 35–900 m (Barthel & Tendal, 1994) but the ANDEEP III collections now extend the lower limit to 1579 m.

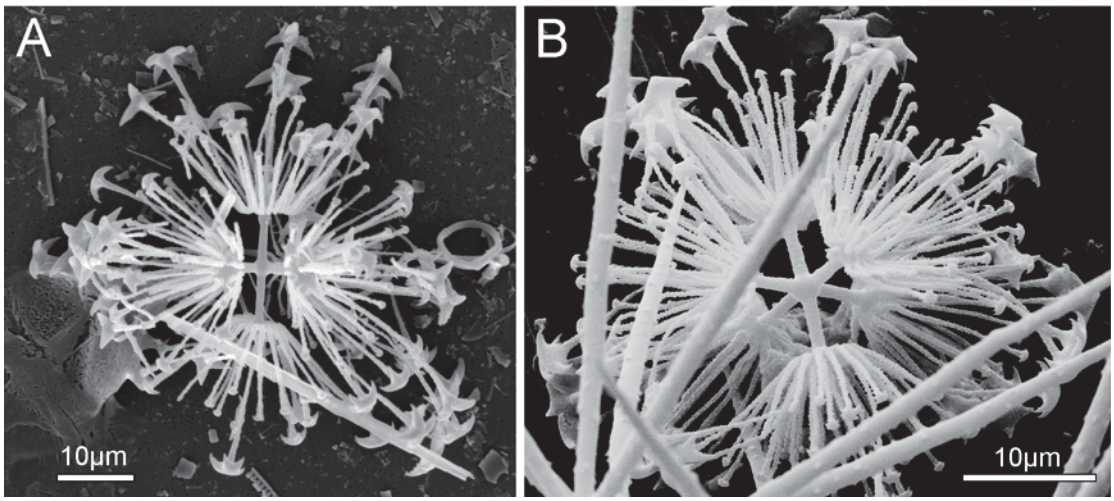

FIGURE 10. Anisodiscohexaster microscleres of (A) *Rossella racovitzae* (SMF 10705) and (B) *Rossella nuda* (SMF 10706) (SEM).

***Rossella* sp.**

Material examined: All from ANDEEP III Exped., Weddell Sea, Antarctica, SMF 10613, and SMF 10601, R.V. 'Polarstern', stn PS67/133-2, Weddell Sea, Antarctica, 16 Mar. 2005, 62°46.49'–46.38'S, 53°02.57'–03.50'W, 1584–1579 m, ethanol.

Description and remarks: Two additional fragments belonging to unidentifiable members of *Rossella* were collected. These fragments have surface spicules, hypodermalia, discohexasters and anisodiscohexasters characteristic of *Rossella*, but are lacking calycocomes and are severely contaminated with demosponge spicules. They cannot confidently be assigned to any of the known *Rossella* sp.

Discussion

A characteristic feature of the Antarctic Porifera fauna is the dense occurrences of large hexactinellid sponges which are commonly dominant among megabenthos on the Antarctic shelf. These spectacular associations of sponges belong to only about 8 species from 2 genera of the family Rossellidae, *Rossella* and *Scolymastra,* which are mostly restricted to moderate depths of 100–600m. This study extends the depth limit of the *Rossella* species, *R. nuda*, down beyond 1500m. However, other members of the Rossellidae, such as *Caulophacus* and *Bathydorus*, are well represented in the Southern Ocean deep-sea. Generally, the diversity of the Hexactinellida increases remarkably towards the deep-sea, from where more than 25 Antarctic species from about 15 genera have been described (Barthel and Tendal, 1994). From the ANDEEP II and III expeditions we have identified 18 species (including denuded fragments of dictyonal skeletons from *Farrea* sp.) belonging to 15 genera and 4 families and one subfamily of the Hexactinellida (Farreidae, Euretidae, Euplectellidae, Rossellidae and Lanuginellinae).

At the same time it is striking that some sponge taxa in the Southern Ocean are rare, to extremely rare. This is true particularly for the hexactinellid subclass Amphidiscophora, the only known Antarctic species was described from one single specimen of *Hyalonema* (*Cyliconema*) *drygalskii* found off Wilhelm II Land (Schulze & Kirkpatrick, 1910). Also the dictyonal Hexactinellida, order Hexactinosida, are poorly represented in the Antarctic. This is true with the exception of a few species, which seem to be rather common, *Chonelasma choanoides*, *Bathyxiphus subtilis* and *Farrea occa*, and a few others, such as *Periphragella antarctica* and *Pararete gerlachei*, which were rarely encountered. However, the number of hexactinellid taxa found in the deep Weddell Sea is still increasing rapidly with each deep-sea expedition: From ANDEEP II, 5 species and one subgenus new to science were described, including the first Antarctic species of the genus *Periphragella* (Janussen et al. 2004). From ANDEEP III, we here describe 2 new species of *Lophocalyx*. It can thus be expected that further new species are still to be discovered in the deep Southern Ocean, including the Weddell Sea.

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